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Sainton et al.

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[54] ADAPTIVE OMNI-MODAL RADIO APPARATUS AND METHODS

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Related U.S. Application Data

[63] Continuation of Ser. No. 167,003, Dec. 15, 1993, abandoned.

[51] **Int. Cl.**^{6} **H04Q 7/32**

[52] **U.S. Cl.** **455/553**; 455/426; 455/557; 455/566

[58] **Field of Search** 455/33.1, 33.2, 455/33.4, 54.1, 54.2, 56.1, 74, 84, 89, 432, 434, 435, 552, 524, 553, 426, 557; 379/59, 60

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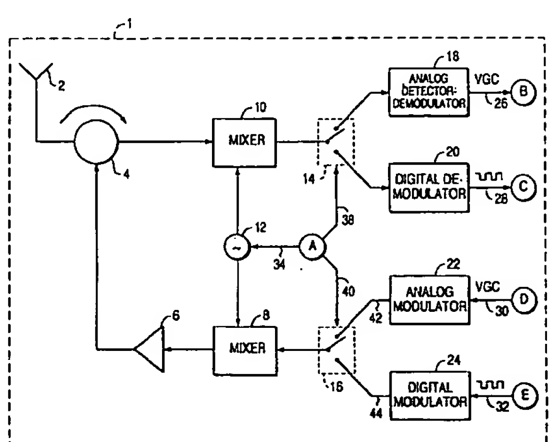
[57] **ABSTRACT**

A frequency and protocol agile wireless communication product, and chipset for forming the same, including a frequency agile transceiver, a digital interface circuit for interconnecting the radio transceiver with external devices, protocol agile operating circuit for operating the radio transceiver in accordance with one of the transmission protocols as determined by a protocol signal and an adaptive control circuit for accessing a selected wireless communication network and for generating the frequency control signal and the protocol control signal in response to a user defined criteria. Among the possible user defined criteria would be (1) the cost of sending a data message, (2) the quality of transmission link (signal strength, interference actual or potential), (3) the potential for being bumped off of the system (is service provider at near full capacity), (4) the security of transmission, (5) any special criteria which the user could variably program into his omni-modal wireless product based on the user's desires or (6) any one or more combinations of the above features that are preprogrammed, changed or overridden by the user. The disclosed invention allows wireless service providers to broadcast electronically as part of any "handshaking"0 procedure with a omni-modal wireless product information such as (1) rate information and (2) information regarding system operating characteristics such as percent of system capacity in use and/or likelihood of being dropped. The disclosed invention creates a user oriented source enrollment and billing service in the wireless data market by establishing uniform standard for "handshakes" to occur between cell service providers and omni-modal wireless products.

15 Claims, 16 Drawing Sheets



Claim 7

US-PAT-NO: 5930295

DOCUMENT-IDENTIFIER: US 5930295 A

TITLE: Mobile terminal apparatus including net radio service in
a mobile satellite service communication system

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Abstract Text - ABTX (1):
A mobile terminal for satellite communication of voice data, facsimile and computer information, which consists of an RF transceiver section, and a processor board. The processor board has two digital signal processors and a multi-task control processor for controlling the operation of the two signal processors. Net radio service is implemented in the mobile terminal and includes a priority 1 mode wherein a channel search is performed on a net radio channel database for an available channel if any problem is initially encountered in obtaining control of a specific

communication channel such as a
channel currently in use or a channel designated for use as a default channel.

TITLE - TI (1):
Mobile terminal apparatus including net radio service in a mobile satellite
service communication system

Parent Case Text - PCTX (2):
This application is related to U.S. Pat. No. 5,742,639, issued Apr. 21,
1998, entitled "Mobile Terminal Apparatus and Method For A Satellite
Communication System," filed in the names of Albert J. Fasulo et al. and
assigned to the assignee of the subject invention, and which is relied upon and
incorporated herein by reference.

Brief Summary Text - BSTX (3):
The present invention relates to mobile terminals for mobile satellite
services (MSS) communications networks and more particularly to such mobile
terminals which are adapted to operate in a net radio communications mode.

Brief Summary Text - BSTX (5):

In U.S. Pat. No. 5,404,375, entitled "Process and Apparatus For Satellite Data Communications" which issued to Brian W. Kroeger et al on Apr. 14, 1995, and assigned to the assignee of the subject invention, there is disclosed a system for transmitting and receiving outbound and inbound data signals through a satellite communications network, the system including a satellite and an end user transceiver for transmitting and receiving the inbound and outbound data signals. The end-user transceiver additionally includes means for transmitting the outbound data signal and for receiving the inbound data signal.

Brief Summary Text - BSTX (6):

Such systems are also known to include a net radio service capability which comprises the satellite equivalent of terrestrial trunked communications systems where a plurality of designated users of a "net" need to communicate with each other in a closed user group that allows each member of the net to hear what any other user is saying. Each member of the net can also talk when

required and thus the system acts like a radio multi-party line.

Brief Summary Text - BSTX (7):

Presently, satellite systems that cover large geographical areas typically use several satellites that follow different paths at low or medium altitudes so that at least one satellite is at all times covering the desired geographical area. From the standpoint of receiving signals, the low and medium altitude satellites have the advantage of being able to transmit a signal that reaches a mobile terminal unit at the earth's surface with a relatively large amplitude and without appreciable fading. However, such satellite networks are limited in their coverage area per satellite.

Brief Summary Text - BSTX (8):

It has been recently proposed, to provide a satellite communications network that utilizes a high altitude geosynchronous satellite which is capable of covering an area corresponding to a substantial portion of the earth, for example, North America, so that a total of approximately

6 satellite beams will
cover the entire continent from Alaska to Mexico. The satellite for such a
network will be approximately 22,600 miles above the equator and will be
designed to operate in the L-Band of RF frequencies. For example, the
frequency of the signal being transmitted to the satellite will be between 1626
MHz to 1660 MHz; and the frequency of the signal received from the satellite
will be between 1525 MHz to 1559 MHz.

Brief Summary Text - BSTX (9):

Energy travelling this great distance undergoes huge attenuation such that
the power flux density incident at the antenna of the mobile unit is
approximately 10.sub.-14 watts per square meter. This grossly attenuated
signal is further degraded by background noise, and other satellite channel
impairments such as Rician fading.

Brief Summary Text - BSTX (11):

In light of the foregoing, there is a need for a mobile terminal unit that
is not only capable of reliably receiving the attenuated signals, subject to

Rician fading, of a high altitude satellite for voice, facsimile, and data communication, but also compact, lightweight, and relatively inexpensive to manufacture.

Brief Summary Text - BSTX (13):

Accordingly, the present invention is directed to a mobile terminal apparatus for a high altitude satellite communication network that is able to be used for Net Radio communication which substantially obviates one or more of the problems due to limitations and disadvantages of the related art. Some of the advantages of the mobile terminal apparatus of the present invention is that it overcomes difficult satellite communication channel characteristics such as low receive power, receive signal fading which is caused by both amplitude and phase effects, and close-in adjacent RF channel interference; and yet is compact, lightweight, relatively inexpensive to manufacture, and is sufficiently flexible and adaptable to permit modification for a variety of different applications with a minimum of hardware redesign.

Brief Summary Text - BSTX (15):

To achieve these and other advantages and in accordance with the purpose of the invention, as embodied and broadly described, the invention is directed to a mobile terminal apparatus having a Net Radio service capability and one comprising a user interface; a digital signal processor board coupled to the user interface; an antenna for radiating and collecting signals from a satellite; an RF section coupled to the antenna for transmitting the signals to be radiated and receiving the collected signals, the RF section being coupled to the processor board for processing the signals received from and transmitted to the RF section.

Detailed Description Text - DETX (5):

The antenna assembly 14 may be one of several different types depending on the particular application of the mobile terminal unit (MT). For land vehicles, a phased array antenna, which is a flat plate of about a foot in diameter, is considered advantageous in that the gain of the antenna in the direction of the signal does not drop below 9 dB and also

because the phased array is aesthetically pleasing on smaller vehicles. The antenna assembly 14 may also be a mechanical antenna which is less rugged. However, the mechanical antenna is advantageous in that it can dither at small intervals, and thus can maintain extremely accurate satellite tracking when used in conjunction with an angular position determinant. A third alternative, is an omnidirectional mast antenna which must be approximately three feet in length. For mobile terminal units with a cellular transceiver, a second antenna 14 is provided.

Detailed Description Text - DETX (6):

The MT of the present invention may be used with a geosynchronous satellite, such as 60, which has broad beam coverage over the geographical regions in which the satellite antennas are pointed. The MT transmits and receives energy to and from the satellite respectively through the one antenna 14. The most dominant feature of the satellite communication link between the satellite 60 and the antenna 14 is the extremely low satellite power that is received. The satellite 60 is assumed to be traveling in an orbit 22,600

miles, above the
equator, and energy traveling this distance to the MT undergoes huge
attenuation, such that power flux density incident at the MT antenna 14 is
approximately -135 dB Watts/Meter.sup.2, or approximately 10-14 watts per
square meter as previously mentioned.

Detailed Description Text - DETX (8):

The transmit signal begins in the processor board 20 as digital data, which
is then converted into digitized, modulated waveform samples. This digitized
waveform, which is created by the processor 37 is conducted to the
digital-to-analog (D/A) converter 34 before the quadrature, modulator
up-converter 32 of the RF section. The converter 32 converts the digitized
waveform into both an analog I (in phase) and Q (quadrature) waveform. The
analog I and Q waveforms are then sent to a mixer or up-converter quadrature
modulator, not shown, where they are upconverted to an L-Band, and then summed
to form a low level L-Band transmit signal on signal line 62. This low level
L-Band transmit signal is amplified by the high power amplifier 30. The

resulting high level L-Band transmit signal then passes through transmit side
of the diplexer 36 and is steered towards the MT antenna 14 from which it
travels to the satellite 60.

Detailed Description Text - DETX (9):
Considering the operation of the processor board 20, the DSP 38 reads the
received signal waveform samples from the A/D converter 28, and processes these
samples as they arrive. The L-Band received signal must be mixed down to a low
IF frequency to aid in signal filtering and also to slow down the A/D sample
rate so that the digital signal processing can keep up with the sample arrival
rate. Once the receive signal has been sampled and loaded into the DSP 38, all
subsequent signal processing is performed by the DSP 38 and DSP 39 as
controlled by the control processor 40. Received signals are demodulated, in
other words translated from their waveform representation into their digital
data representation, decoded and packaged for voice, fax or data processing at
the DSP 39. The signal degradations of the high altitude satellite are
mitigated by the channel protocol and data encoding

scheme herein described.
For example, repeat strategies, a combination of forward error correction,
interleaving and scrambling, all aid in minimizing and spreading the effect of
errors on the channel. The demodulator of the digital signal processor 38
achieves signal acquisition and tracking under degraded receive signal
conditions. All of these functions are implemented digitally in software
within the processor board 20 of the MT.

Detailed Description Text - DETX (10):
The control processor or CP 40 performs byte level and waveform
manipulations while the DSP's 38 and 39 perform bit level and waveform
manipulations. The DSP 38 implements the modem as well as the real time
satellite framing function that includes circuit switched, and signaling frame
formats together with low level bit manipulation algorithms. An executive loop
provides overall control and call sequence around which the processing
functions are built. Interrupt Service Routines (ISR) are used to feed the
signals from the DSP 38 to the DSP 39, and from the DSP's 38 and 39 to CP 40

communication interfaces.

Detailed Description Text - DETX (15):
In a circuit switched (CS) voice mode, hereinafter referred to as the Voice Single Channel per Carrier (SCPC) Mode, the MT of the present invention operates in a full duplex mode, simultaneously transmitting and receiving voice mode frames. The timing of the transmit and receive satellite channels are, moreover, asynchronous to one another.

Detailed Description Text - DETX (18):
The main purpose of the receive framing function 66 is to unpack the information data contained within the satellite frame. The receive framing function 66 is commenced each time a block of 16 symbols has accumulated. In the voice mode, the receive framing function 66 detects frame boundaries in the data stream at function 84, buffers subframes at function 86, and then descrambles each of the voice subframes (VSF) or signaling units (SUs), as the case may be, at 88. As opposed to a voice communication signal, a signalling unit, hereinafter referred to as an SU is a message sent

or received containing
a command to be carried out or a response to a command. The frame boundaries
are located by the UW correlator/frame synchronizer 84 which performs an
auto-correlation on a 24-bit frame marker sequence UW. Processed VSFs or SUs
(128 soft decisions) from the function 84 are buffered at 86 and fed serially
after being descrambled at function 90 to the DSP 39. This serial feeding is
accomplished by an ISR of DSP 38.

Detailed Description Text - DETX (19):
The decode function 72 of the DSP 39 includes a soft decision buffer 108
which is fed by serial receive ISR. This routine reads one word (16-bits of
data) at a time and sets a flag when a complete subframe has been buffered. A
voice decoder function 110 is called every 20 milliseconds regardless of
whether a Received Voice Subframe (VSF) is present since the voice decoder 110
is a slave to voice transmit timing. If a received VSF is present, it is input
to the voice decoder function 110. If a VSF has not yet arrived due to the
asynchronous nature of the satellite transmit and receive chains, or, if a SU

has been substituted for a VSF, the voice decoder 110 is called with the subframe repeat flag set. This allows the voice decoder to maintain its timing and signal history even when a VSF is not available for decoding. The voice decoder 110 outputs 20 ms worth of digital samples to a D/A buffer 112. These samples are fed to the D/A serial interface by the ISR associated with the D/A 112. If a signal unit SU is present, a Viterbi decoder 114 is activated after the voice decoder 110 completes its function. The Viterbi decoder 114 reverses the forward error correction (FEC) and coding applied to the data at the transmitter and also attempts to correct bit errors. Viterbi decoded SUs (96 "hard" bits) are read from the SRAM of the DSP 39 by the control processor 40 in response to an interrupt from the DSP 39 as shown at line 116 of the Viterbi decoder 114.

Detailed Description Text - DETX (21):

The primary purpose of the transmit framing function 70 is to package information data, both VSF and SU, into a voice mode <u>satellite</u> frame format. While there is voice activity, the frame format data

function 104 builds voice frames consisting of a 24-bit frame marker unique word (UW) sequence followed by six VSFs or 5 VSFs and a signaling unit (SU). SUs which are used to convey system control information are passed to DSP 39 from the CP 40. These SUs are three-quarter rate forward error correction convolutionally encoded at 102 before they are scrambled at 100, and differentially encoded at 98. VSFs bypass the encoder in DSP 38 since they are block encoded by the voice encoder 120 in DSP 39. Unique Word (UW) sequences bypass all but the differential encoder as seen at line 121. All processed bits are output to the transmit buffer 96 which feeds the modulator function 68.

Detailed Description Text - DETX (31):

The responsibility of the demodulator portion of the DSP 38 is to convert the satellite received samples to packets of "soft" bits which are routed to the DSP 39 for further processing. On the transmit side, packets of bits are converted to digital samples by the modulator for transmission over the satellite link. Thus, the demodulator 64 and the modulator 68 are, in fact, a

bidirectional pipeline process which is time intensive and one dimensional from a functional standpoint. In accordance with the present invention, the functions of the modulator, demodulator portion of the DSP 38 is operated from a main or executive loop instead of using an operating system. This has the advantage of reducing cost and minimizing execution cycles and memory.
However, without an operating system, the timing requirements of the four functional partitions, that is, the demodulator 64, the receive framing 66, the modulator 68, and the transmit framing 70 are such that the routines are allowed to run to completion. This is accomplished by operating the demodulator 64 and the receive framing 66, sometimes referred to as a receive chain, on a block basis, or in other words, on a basis of multiple samples or bits. This operation is in contrast to operating the demodulator and receive framing on each sample or bit as it arrives. The block basis operation permits both the receive and transmit chains to run to completion before the next block of samples arrives. In the preferred embodiment, the chosen block size is 32 bits (sometimes referred to as 16 symbols) which at a

6750 bit-per-second transmission rate is equivalent to 32/6750 or 4.74 microseconds per each block.

Detailed Description Text - DETX (39):

Only two interrupt levels are used in order to provide flexibility in processor selection. Events are driven by external interrupts from the DSPs 38 and 39 for transmit and receive data on the satellite side of the MT, and from the handset, DTE, or fax ports on the user side of the MT. The DSP events, which cause an interrupt 3, are associated with data received from and transmitted to the satellite link. The handset, cellular radio and fax events generate the interrupt 3; and the data port and BSC events generate the interrupt 2. The interrupt service routines (ISR's) are not formal tasks, but interact with the tasks by setting event flags based on the source and specific cause of the particular interrupt.

Detailed Description Text - DETX (44):

The BSC I/F task coordinates the steering of the antenna main beam toward the satellite, processes the beam steering controller

control messages and
formats commands to the BSC, receives signal strength updates from the DSP
demodulator and forwards the signal strength to the BSC and responds to BSC
status changes.

Detailed Description Text - DETX (50):

This set of tasks processes the keystrokes from the handset, services
requests from other tasks to display indicators and text on the handset,
arbitrates call requests/announcements among the handset, and satellite modem,
implements special features invoked by handset such as store/recall number,
call timer, handsfree operation, and the like. In addition, this set of tasks
controls the entry/display of configuration values such as enabled options,
serial port data rate/character format, and operating mode.

Detailed Description Text - DETX (68):

Net Radio service is initiated by pressing function keys 61 of a handset 53
such as shown in FIG. 4. By pressing the "FCN" button of keys 61, and the
button designated for comm mode of the keys 71 to bring

**up a COMMUNICATIONS
mode (COMM MODE) selection, the user then scrolls by means of up or down arrow
keys 63 and 65 until the words "Net Radio" appears on the handset's display 67.
Another button of keys 61 identified as the storage (STO) key, is then
depressed. Next, the "RCL" key of keys 61, followed by the up or down arrow
<u>keys 63 and 65 is used to select which channel</u> of a plurality of nets to tune,
with the net ID being displayed by the handset display 67.**

Claims Text - CLTX (1):

**1. A mobile terminal apparatus having a transceiver with a user interface,
and an antenna for both radiating and collecting RF signals to and from a
<u>satellite,</u> the transceiver comprising:**

Claims Text - CLTX (19):

**12. A method of making a priority 1 net radio service mode call in a mobile
terminal of a mobile <u>satellite</u> service system and overriding any previously
established net radio talker in order to obtain control of a specific
communication channel or to initially set up a call where**

a desired net channel
is available or not currently active, comprising the steps of:

Current US Cross Reference Classification - CCXR (3):
455/11.1

Current US Cross Reference Classification - CCXR (4):
455/430

Current US Cross Reference Classification - CCXR (5):
455/434

Current US Cross Reference Classification - CCXR (6):
455/557

US-PAT-NO: 6665284

DOCUMENT-IDENTIFIER: US 6665284 B1

TITLE: Apparatus, and associated method, for receiving data at
a radio device

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Brief Summary Text - BSTX (8):

Users of a cellular communication system are able to communicate
telephonically by way of mobile stations to communicate voice information,
herein referred to also as voice data. Utilization of digital communication
techniques has also facilitated the communication of other types of data,
herein referred to as non-voice data. Various standards have also been
developed which pertain to the communication of non-voice data. For instance,
an HDR (High Data Rate) data communication system standard has been
promulgated. A communication system constructed to comply with the HDR

standard provides for the communication of non-voice information at high data
rates.

Brief Summary Text - BSTX (9):

Mobile stations have been constructed to permit communication therethrough
of both voice, and other, data generated pursuant to operation of an
IS-95/IS-2000 system as well as also non-voice, and other, data generated
during operation of an HDR system. The IS-2000 system, for instance, is
capable of data rates of 614.4 kbps while HDR data rates approach 2.45 Mbps.
Data generated during operation of the HDR system is transmitted to a mobile
station within a first frequency band, and IS-95/IS-2000 data transmitted to
the mobile station is transmitted within a second frequency band. Conventional
mobile terminals operable to receive data generated pursuant to data generated
pursuant to both of the systems include a receive portion which must effectuate
a hard handover between frequency bands, alternately to receive the data
generated during operation of the separate systems. For instance, the mobile
terminal is normally tuned to the frequency band upon

which the HDR data is
transmitted but, a hard handover to the frequency band upon which the
IS-95/IS-2000 data is transmitted is effectuated at selected intervals to
detect transmission of information such as IS-95/IS-2000 where the paging
channel carries targeted user information. Subsequent to the hard handover to
the frequency band upon which the data is transmitted, the mobile terminal is
unable to detect the data generated pursuant to operation of the HDR data
system. Interruption of the reception of the HDR data results.

Brief Summary Text - BSTX (15):
In one aspect of the present invention, a receive portion of a radio device
is provided with a first RF (Radio Frequency) received chain and a second RF
(Radio Frequency) receive chain positioned in parallel and permitting of
simultaneous operation. During normal operation, both of the receive chains
are together operable as a diversity receiver to receive first data generated
pursuant to a first communication service. At selected intervals, one of the
receive chains is tuned to a paging channel associated

with with IS-95/IS-2000
with a second communication service. When tuned to the frequency channel
associated with the second communication service, a determination is made as to
whether second data is to be communicated to the mobile terminal. If so, the
receive portion, already tuned to the frequency band upon which the second data
is to be communicated, remains tuned to such frequency band. Otherwise, the
receive portion is retuned back to the frequency band upon which the non-voice
data is communicated. Although diversity reception is no longer performed when
one of the receive portions is retuned to the frequency band upon which the
second data is to be communicated, the other of the RF receive portions remains
tuned to the frequency band upon which the first data is communicated.
Thereby, continuous reception of the first data is permitted.

Brief Summary Text - BSTX (18):
In another aspect of the present invention, when a paging signal is
detected, the transmit portion of the mobile terminal is also caused to be
tuned to the frequency band associated with the second

data service. Thereby, the mobile terminal is operable both to receive and to send voice data pursuant to the second data service.

Detailed Description Text - DETX (30):

Structure of the mobile station is also operable when the channels associated with f1 and f2 belong to a MC 3.times.carrier set. The carrier set is, e.g., denoted by the frequency set [F-1, F, F+1] in which f1 and f2 belong to the set. In operation, an advantageous reduction of hardware resources is permitted while retaining the advantages of the structure of the receiver part of the mobile station. Support of concurrent voice and data services is provided.

Current US Cross Reference Classification - CCXR (3):

455/553.1